

CLAIMS

1. A glycolic acid copolymer comprising:

(a) 80 to less than 95 % by mole of glycolic acid  
5 monomer units,

(b) 5.0 to 20.0 % by mole of non-glycolic, hydroxycarboxylic acid monomer units, and

(c) 0 to 0.10 % by mole of diglycolic acid monomer  
units,

10 said non-glycolic, hydroxycarboxylic acid monomer  
units (b) constituting a plurality of segments each independently consisting of at least one non-glycolic,  
hydroxycarboxylic acid monomer unit (b), wherein said  
segments have an average chain length of from 1.00 to  
15 1.50 in terms of the average number of non-glycolic,  
hydroxycarboxylic acid monomer unit or units (b),

the total of said components (a), (b) and (c) being 100 % by mole,

said glycolic acid copolymer having a weight average  
20 molecular weight of 50,000 or more.

2. The glycolic acid copolymer according to claim 1,  
wherein the weight average molecular weight of said  
glycolic acid copolymer is 80,000 or more.

3. The glycolic acid copolymer according to claim 1 or 2, wherein the amount of diglycolic acid monomer units (c) is from more than 0 to 0.09 % by mole, based on the total molar amount of components (a), (b) and (c).

4. The glycolic acid copolymer according to any one of claims 1 to 3, wherein the weight average molecular weight of said glycolic acid copolymer is 100,000 or more.

5. The glycolic acid copolymer according to any one of claims 1 to 4, wherein the average chain length of said segments each independently consisting of at least one non-glycolic, hydroxycarboxylic acid monomer unit (b) is from 1.00 to 1.20.

6. The glycolic acid copolymer according to any one of claims 1 to 5, wherein said non-glycolic, hydroxycarboxylic acid monomer units (b) are non-glycolic, monohydroxymonocarboxylic acid monomer units.

7. The glycolic acid copolymer according to any one of claims 1 to 6, which further comprises a polyol monomer unit (d).

8. The glycolic acid copolymer according to claim 7,  
wherein said polyol monomer unit (d) comprises at least  
one member selected from the group consisting of mono-  
5 mer units derived from a diol having 3 or more carbon  
atoms and monomer units derived from a compound having  
4 or more carbon atoms and 3 or more hydroxyl groups in  
the molecule.

10 9. The glycolic acid copolymer according to claim 8,  
wherein said polyol monomer unit (d) comprises a mono-  
mer unit derived from a polyol having 5 or more carbon  
atoms and 2 or 3 hydroxyl groups in the molecule.

15 10. The glycolic acid copolymer according to claim 9,  
wherein said polyol monomer units (d) are neopentyl  
glycol monomer units.

11. The glycolic acid copolymer according to any one  
20 of claims 7 to 10, which further comprises a polycar-  
boxylic acid monomer unit (e) other than diglycolic  
acid monomer units, wherein the total amount of the  
polyol monomer units (d), the polycarboxylic acid mono-  
mer units (e), and the diglycolic acid monomer units  
25 (c) is less than 2.0 % by mole, based on the total mo-

lar amount of components (a), (b), (c), (d) and (e).

12. The glycolic acid copolymer according to claim 11,  
wherein the total amount of the polyol monomer units  
5 (d), the polycarboxylic acid monomer units (e), and the  
diglycolic acid monomer units (c) is from more than  
0.02 to less than 2.0 % by mole, based on the total mo-  
lar amount of components (a), (b), (c), (d) and (e),  
and the amount of the polyol monomer units (d) is from  
10 0.02 to less than 2.0 % by mole, based on the total mo-  
lar amount of components (a), (b), (c), (d) and (e).

13. The glycolic acid copolymer according to any one  
of claims 1 to 12, wherein said non-glycolic, hydroxy-  
15 carboxylic acid monomer units (b) comprise at least one  
member selected from the group consisting of lactic  
acid monomer units and 6-hydroxyhexanoic acid monomer  
units.

20 14. The glycolic acid copolymer according to any one  
of claims 1 to 13, which is obtained by polycondensing  
at least one starting material selected from the group  
consisting of glycolic acid and a derivative thereof  
with a reactant copolymerizable with said at least one  
25 starting material, wherein said reactant comprises at

least one member selected from the group consisting of a non-glycolic, hydroxycarboxylic acid and a derivative thereof.

- 5        15. A method for producing a glycolic acid copolymer, which comprises the steps of:

          (A) providing a raw material mixture comprising at least one starting material selected from the group consisting of glycolic acid and a derivative thereof, and a reactant copolymerizable with said at least one starting material, wherein said reactant comprises at least one member selected from the group consisting of a non-glycolic, hydroxycarboxylic acid, a derivative thereof and optionally at least one compound selected from the group consisting of a polyol, a polycarboxylic acid and a derivative of the polycarboxylic acid, and  
10        subjecting said raw material mixture to a preliminary polycondensation reaction at a temperature in the range of from 20 to 160 °C, thereby obtaining a reaction mixture containing a glycolic acid copolymer prepolymer having a weight average molecular weight of from 700 to 5,000,

          (B) elevating the temperature of the reaction mixture to 190 °C within a period of 100 minutes as measured from the start of the temperature elevation in  
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step (B), and

(C) performing a heat treatment of said reaction mixture at a temperature in the range of from 190 to 300 °C to effect a final polycondensation reaction, wherein said final polycondensation reaction is performed so as to obtain a glycolic acid copolymer having a weight average molecular weight of 10,000 or more, wherein said final polycondensation reaction is performed under conditions wherein the increasing rate of weight average molecular weight of the glycolic acid copolymer being produced is maintained at 1,000 per hour or more until the weight average molecular weight reaches at least 10,000.

16. The method according to claim 15, wherein said heat treatment for effecting the final polycondensation reaction is performed so as to obtain the glycolic acid copolymer of any one of claims 1 to 14, which has a weight average molecular weight of 50,000 or more.

17. The method according to claim 15, wherein said raw material mixture satisfies the following formulae (1) to (3):

$$0.8 \leq X^1 \leq 0.95$$

(1),

$$0.05 \leq X^2 \quad (2), \text{ and}$$

$$X^1 + X^2 + X^3 + X^4 = 1 \quad (3)$$

wherein:

$X^1$  represents the calculated molar ratio of  
said at least one starting material selected  
from the group consisting of glycolic acid and  
a derivative thereof,

$X^2$  represents the calculated molar ratio of  
said at least one member selected from the  
group consisting of a non-glycolic, hydroxycar-  
boxylic acid and a derivative thereof,

$X^3$  represents the calculated molar ratio of an  
optional polyol,

$X^4$  represents the calculated molar ratio of at  
least one optional raw material selected from  
the group consisting of a polycarboxylic acid  
and a derivative thereof,

said calculated molar ratio of each raw  
material being defined as the ratio of the mo-  
lar amount of the unit structure obtained by  
hydrolysis of each raw material to the total  
molar amount of the unit structures of all raw  
materials, and

each of  $X^3$  and  $X^4$  is independently 0 or more.

18. The method according to claim 17, wherein said raw material mixture satisfies the following formulae (4) and (5):

$$\frac{X^4}{X^1 + X^2} \leq 0.001 \quad (4), \text{ and}$$

$$0 < \frac{X^3}{X^1 + X^2} \leq 0.01 \quad (5),$$

wherein  $X^1$  to  $X^4$  are as defined for formulae (1) to (3) above, provided that  $X_3$  is more than 0, and  $X^4$  is 0 or more.

19. The method according to claim 17, wherein said raw material mixture satisfies the following formulae (6) and (7):

$$0.001 < \frac{X^4}{X^1 + X^2} \leq 0.088 \quad (6), \text{ and}$$

$$1 \leq \frac{X^3}{X^4} \leq 2 \quad (7),$$

wherein  $X^1$  to  $X^4$  are as defined for formulae (1)



to (3) above, provided that each of  $X^3$  and  $X^4$  is more than 0.

20. The method according to claim 17, wherein said raw  
5 material mixture satisfies the following formula (8):

$$0.0002 \leq \frac{X^3 + X^4}{X^1 + X^2 + X^3 + X^4} < 0.02 \quad (8),$$

10 wherein  $X^1$  to  $X^4$  are as defined for formulae (1) to (3) above, provided that  $X^3$  is more than 0, and  $X^4$  is 0 or more.

21. A method for producing a glycolic acid copolymer  
15 of any one of claims 1 to 14, which comprises the steps of:

crystallizing the glycolic acid copolymer obtained by the method of claim 15, thereby obtaining a crystallized glycolic acid copolymer, and

20 subjecting the obtained crystallized glycolic acid copolymer to a solid phase polymerization, thereby increasing the degree of polymerization of the crystallized glycolic acid copolymer.

25 22. The method according to claim 21, wherein said

crystallized glycolic acid copolymer before the solid  
phase polymerization has a weight average molecular  
weight of 25,000 or more, as measured by gel permeation  
chromatography using, as an eluent, an 80 mM sodium  
5 trifluoroacetate solution in hexafluoroisopropanol and  
using a calibration curve obtained with respect to  
standard monodisperse polymethyl methacrylate samples.

23. A shaped article obtained from the glycolic acid  
10 copolymer of any one of claims 1 to 14.